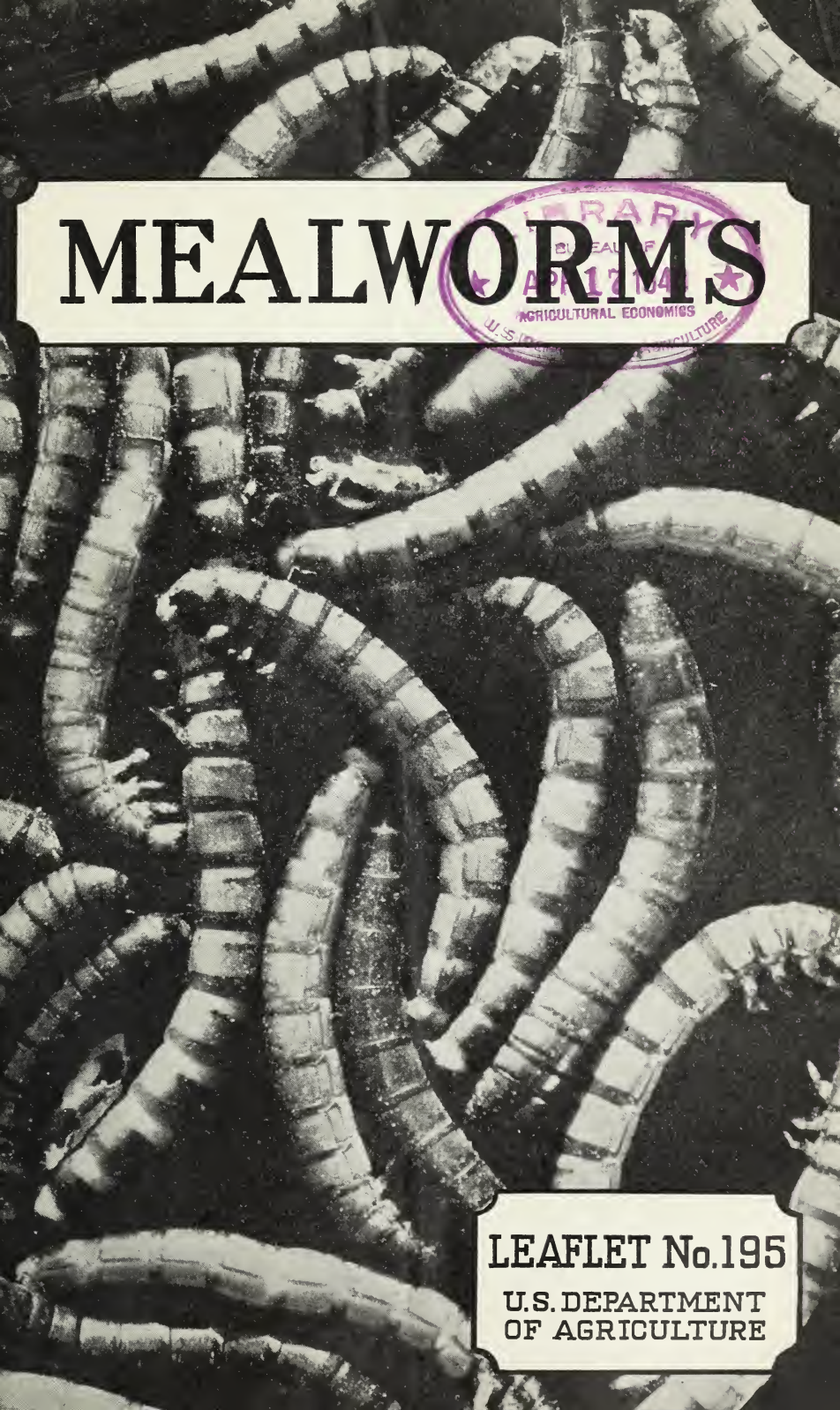


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The background of the entire page is a high-contrast, black and white photograph of numerous mealworms (Tenebrio molitor) crawling over each other. The worms are shown in various orientations, with their segmented bodies and legs clearly visible. The lighting creates strong highlights and shadows, emphasizing the texture of their exoskeletons.

MEALWORMS



LEAFLET No.195

**U.S. DEPARTMENT
OF AGRICULTURE**

MEALWORMS

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Of the many insects found associated with stored grain and milled cereal products, the mealworms are the most easily recognized. They resemble wireworms in appearance and when fully grown are from 1 to 1¼ inches in length. They are found in all parts of the world and have long been familiar to both scientists and laymen because of their usefulness as food for birds, reptiles, fish, and small mammals, as well as for their reprehensible habit of breeding in supplies of grain and milled cereals.

The mealworms are the larvae of large black beetles belonging to the genus *Tenebrio*, a name derived from a Latin word meaning "darkness" and very appropriately applied to these insects that are nocturnal in habit and frequenters of dark places.

Two species of mealworms are common in this country, the yellow mealworm (*Tenebrio molitor* L.) and the dark mealworm (*T. obscurus* F.) (fig. 1, B). The yellow mealworm is so named because of its honey-yellow color. It is also known as the European mealworm because of the many reports of its occurrence in Europe. The dark mealworm is easily distinguished from the yellow one by its dark-brown color. This species is sometimes called the American mealworm for the reason that it was originally supposed to have been a native of North America. In all probability both species are of European or Asiatic origin.

Habits

The mealworms are inclined by nature to be scavengers and prefer to feed on decaying grain or milled cereals that are damp and in poor condition. The two species have similar feeding habits and they are frequently found living together. They do not restrict their feeding to decaying products, however, but will devour meal, flour, bran, grain, coarse cereals, bread, crackers, mill sweepings, meat scrap, feathers, the bodies of dead insects, and many similar materials.

They are usually found in dark, damp places, in accumulations of grain in neglected corners of mills, under bags of feed in warehouses and feed stores, in grain bins where some of the grain has become damp, or in the litter of chicken houses and bird houses where feathers and refuse grain are mixed with excrement.

When fully grown, the worms have a tendency to wander about, probably in search of a place to pupate and transform to the beetle stage. They frequently wander in large numbers into strange places and cause more trouble by their mere presence than by the actual damage done in feeding. They have been found in bags of fertilizer and salt, boxes of soda ash, bales of tobacco, ground black pepper, and similar unusual surroundings. In one case a warehouse con-

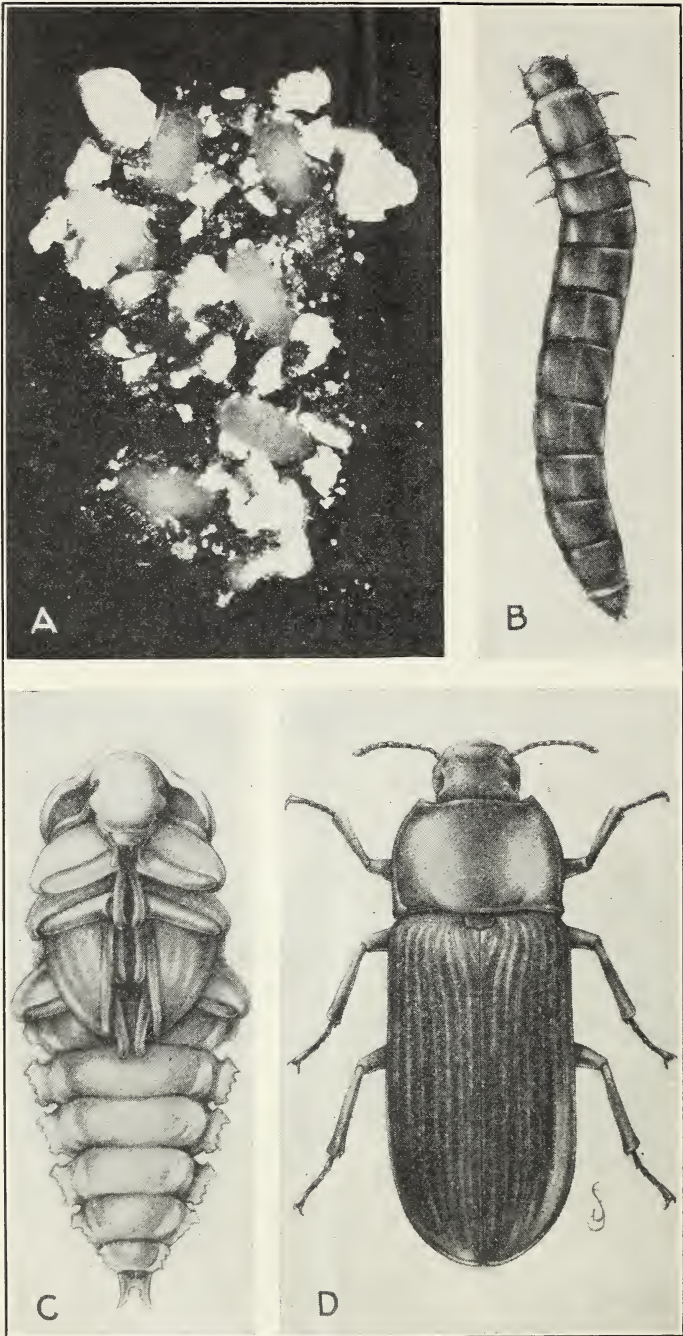


FIGURE 1.—The dark mealworm: A, Eggs, $\times 12$; B, full-grown larva, $\times 3$; C, pupa, $\times 4$; D, adult beetle, $\times 4$.

taining bagged feed was invaded by thousands of the worms that crawled by the dozens into the ears of the feed bags. They did not attempt to penetrate the bags of feed but were merely seeking a place of concealment in which to pupate. Unfortunately the presence of the worms in such large numbers ruined the sale of the feed, as the prospective buyer, catching hold of a bag of feed by the ears, would be startled to find himself clutching a handful of worms. Investigation showed that the worms were breeding on the ground under the warehouse in accumulations of meal and cereal dust that had sifted through the floor. After becoming fully grown, the worms had crawled up the walls of the building and through cracks between the wall and the timbers of the floor and thus reached the bags of feed.

Life History

Mealworms normally pass the winter in the worm or larval stage. The adults emerge in the spring and early summer months, live 2 to 3 months, and die. Under natural conditions there is, therefore, only one full generation a year. In experiments under laboratory conditions occasional individuals of the dark mealworm developed from the egg to the adult stage in as short a time as 4 months, transforming to the beetle stage in June, July, or August instead of waiting until the following spring. On the other hand, some individuals took 2 years to complete their development. Under similar conditions no specimens of the yellow mealworm completed their development in less than 10 months, and slightly more than half of the specimens reared individually required 2 years to complete their development.

The white, oblong-oval eggs (fig. 1, *A*) are about one-twentieth of an inch long. They are laid singly or in small clusters, usually loosely in the material in which the insects are living. When first laid, they are covered with a sticky secretion that causes them to become quickly coated with particles of the foodstuff in which they are deposited. The incubation period is influenced chiefly by the weather and lasts from 4 days to a week at normal spring or summer temperatures. With lower temperatures the incubation period may be lengthened to as much as 19 days.

The larval period varies considerably. In the case of the dark mealworm the minimum larval period observed was 79 days and the maximum was 642 days, whereas in the case of the yellow mealworm the shortest normal larval period was 281 days and the longest was 629 days. The larvae molt, or cast their skins, many times in the course of their lives, but the number of molts varies considerably. For the dark mealworm the smallest number of molts recorded was 12 and the greatest number was 22, and for the yellow mealworm the smallest number of molts recorded was 9 and the largest number for any one larva was 20.

After becoming apparently full-grown the larvae may change to the pupal form (fig. 1, *C*) or may remain for many months with little change in size or outward appearance. Of 50 larvae of the dark mealworm kept without food or moisture at ordinary room temperature, 25 survived 6 months, 8 survived 8 months, and 1 survived 9 months. In heated buildings the larvae of the dark mealworm normally begin to pupate in November and continue pupating throughout the winter and spring months, whereas larvae of the yellow meal-

worm have not been observed to pupate before January. In unheated situations pupation does not occur until spring or early in the summer.

The pupae of both species are from one-half to three-fourths of an inch long. When first formed they are white, except for the tip of the caudal spine and the lateral appendages. As the pupae become older they change to a yellowish brown. They are always naked and unprotected by pupal cases. The pupal period of the dark mealworm was observed to range from a maximum of 20 days during January and February with a mean temperature of 65° F. to a minimum of 7 days in June when the mean temperature ranged from 77° to 78°. That of the yellow mealworm ranged from a maximum of 18 days during February with a mean temperature of 65° to a minimum of 6 days in June with a mean temperature of 81°. When pupation is complete the pupal skin is cast off, and the adult appears.

The adult beetles of the two species closely resemble each other in size and form but are readily distinguishable. The adult of the yellow mealworm is shining brown to almost black, whereas that of the dark mealworm (fig. 1, *D*) is a dull pitchy black. The beetles of both species vary considerably in size, ranging from about half an inch to nearly an inch in length. They appear in numbers in the spring, but in heated buildings an occasional beetle may be seen during almost any month of the year. They are not long-lived in comparison with many of the other pests of stored grain, the average longevity being about 2 months for the adult of the yellow mealworm and 3 months for the adult of the dark mealworm. One female yellow mealworm beetle, however, was observed to live 92 days and a female of the dark mealworm 152 days. The beetles are prolific egg layers. Females of the yellow mealworm lay an average of about 275 eggs and a maximum of about 600, and females of the dark mealworm lay an average of about 475 and a maximum of about 1,000 eggs.

Directions for Rearing Mealworms

The use of mealworms for fish bait or as food for birds and small mammals has created a steady demand for information regarding methods of rearing them. Mealworms can be reared with very little effort and attention if the proper precautions are taken. A wooden box or flat approximately 8 or 10 inches deep, 2 feet long, and 18 inches wide makes a satisfactory container or cage. A suitable lid can be made by perforating with small holes a thin sheet of zinc cut to fit inside the rim of the box and rest on a narrow wooden batten or strip all around. This cover can be easily removed and will allow good ventilation.

The box should be filled to within about 2 inches of the top with wheat bran, to which should be added a little graham flour and commercial meat scrap. Since the worms like moist foodstuffs their diet should be varied by the addition from time to time of raw fresh vegetables such as carrots, potatoes, or lettuce. Supplies of these vegetables should not be mixed in with the bran but placed on a thin piece of board or metal laid on top of the bran. This tray can be removed at intervals and cleaned. Care should be taken to keep the bran from becoming too moist, as otherwise molds or mites may develop and ruin the culture. Fresh bran should be added as needed.

The culture can be started by introducing from 500 to 1,000 larvae or beetles, whichever can be obtained. Fresh cultures can be started each spring, as many boxes being used as the demand requires.

If it is ever found desirable to speed up development to secure a supply of adult beetles in the fall, the usual hibernation period of the dark mealworm can be prevented by exposing the full-grown larvae to continuous light. This will cause many of them to pupate and transform to the beetle stage in a few weeks' time.

Control Measures

Satisfactory control of mealworms can be obtained through the periodic cleaning up of accumulations of grain, meal, flour, sweepings, and refuse in mills, warehouses, granaries, and elevators, or under loading docks or floors through which such products sift.

For the treatment of stored grain that has become infested with mealworms nothing is better than fumigation. Detailed information on this subject will be found in Farmers' Bulletin 1483 of the United States Department of Agriculture, entitled "Control of Insect Pests in Stored Grain."

